STUDIES OF CLIMATE-DRIVEN CHANGES IN LAKE LEVELS ASSIST IN DECISION-MAKING IN THE GREAT LAKES REGION

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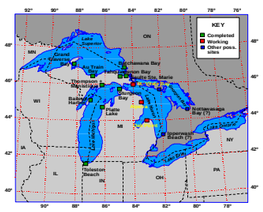
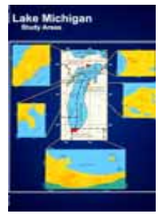
ABSTRACT: The effects of climate change on Great Lakes wetlands are both directly and indirectly tied to climate-driven changes in lake levels. We conducted studies to evaluate those linkages and their effects on wetland plant communities, as they occurred in the past, as a means of predicting potential future responses to climate change. The studies made use of chronosequences of beach ridges and wetlands that form in strandplains in large embayments along the shores of the lakes. Each beach ridge was formed at the end of a high lake-level period corresponding to a short-term cooling event (about every 33 years in lakes Michigan and Huron). High lake levels also occurred in longer quasi-periodic cycles (about 160 years), with the short-term cycles encompassed within them. These longer-term events clearly match records of past climate change from other sources and represent a proxy for climate change in the upper Great Lakes region over the past 4700 years. These findings have had a profound effect on decision-making in the Great Lakes region. Studies conducted under the International Joint Commission's Lake Ontario-St. Lawrence River Reference Study to develop a new water-level-regulation plan for Lake Ontario have recognized these patterns and their role in development and maintenance of wetland plant communities. The results also portend future water supplies to Lake Ontario that affect plans for regulation. An International Joint Commission study to review the regulation plan for Lake Superior is also being considered; similar climate-change studies have produced a long-term lake-level record specific to Lake Superior that will be instrumental in evaluating environmental components of that study, as well as foretelling what the future may hold with respect to all other study components. In addition to predicting effects of future climate change on Great Lakes wetlands, study results have also been used to reevaluate rates of rebound of the earth's crust in the upper Great Lakes region following melting of Wisconsinin glaciers, to reevaluate the separation of Lake Superior from lakes Michigan-Huron more than a millennia ago, and to develop an understanding of dune development processes along the shores of the lakes that are critical to land managers.

DEVELOPMENT OF A LONG-TERM PROXY FOR CLIMATE CHANGE



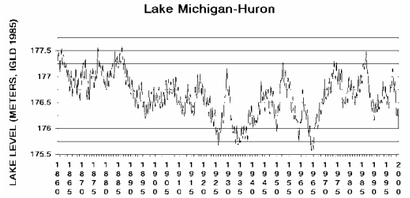
U.S.G.S. study sites for climate-change research in the upper Great Lakes. Each site contains a chronosequence of beach ridges and wetlands formed in large embayments of the lakes.



Lake Michigan study sites with beach ridges shown for each embayment. The ridges formed during successive high lake stages and gradually filled in the embayments.

Oblique air photo of the Manistique embayment in northern L. Michigan showing ridges lined with trees and intervening wetlands. Older ridges are to the left. Younger ridges and L. Michigan are to the right.

Photographs showing a variety of wetlands between beach ridges.



The recorded lake-level history of Lake Michigan-Huron dates back to 1860 and does not provide a long-term understanding of lake-level behavior, as dictated by changes in climate.

Collecting a sediment core from the lakeward side of a beach ridge using a vibra-corer. The elevation of the lake at the time the beach ridge formed is preserved in the sediment record.

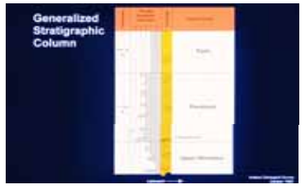
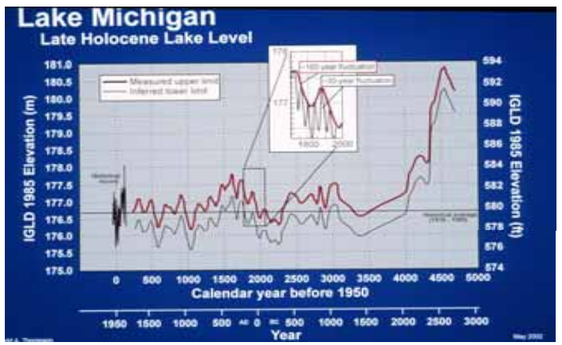
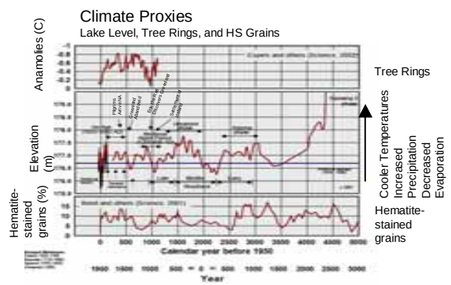


Diagram depicting the sediments typically found in a vibracore. The increase in grain size at the plunge point indicates lake level at the time the beach ridge formed. Past lake-level data from the full suite of beach ridges, coupled with radiocarbon dates from intervening wetlands, allows a long-term lake-level record to be constructed.



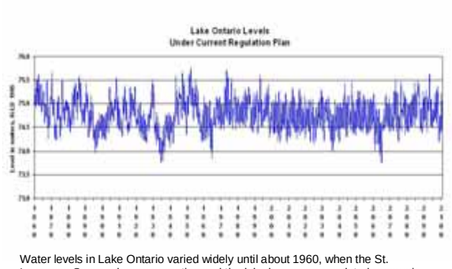
4700-year paleo lake-level record for Lake Michigan-Huron.

High lake levels responding to cooler climatic periods occurred about every 160 years, although the elevations differed widely between peaks. Each 160-year event is composed of five 30- to 33-year high lake levels. Longer cooling periods occurred 2300-3100 years ago and 1400-1900 years ago.

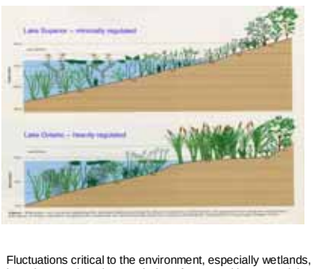


The lake-level record serves as a proxy for climate change in the upper Great Lakes region. Known human events are shown to correlate with past warm and cool climate periods. The lake-level proxy also matches other well-known proxies for climate change.

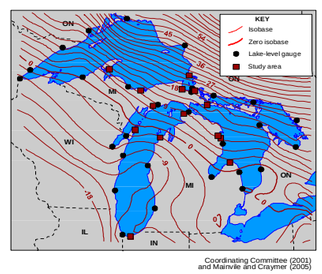
LONG-TERM LAKE-LEVEL RECORDS ASSIST IN DECISION-MAKING



Water levels in Lake Ontario varied widely until about 1960, when the St. Lawrence Seaway began operation and the lake became a regulated reservoir. Projections for the next century show more of the same.

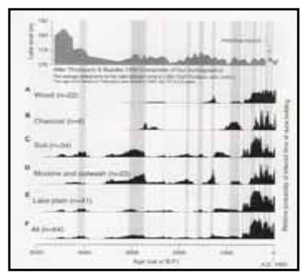


Fluctuations critical to the environment, especially wetlands, have been reduced. Knowledge of expected long-term lake-level behavior assisted in International Joint Commission studies to develop a new regulation plan for the lake. A paleo lake-level record specific to Lake Superior will serve as a foundation for a proposed new IJC study to reevaluate regulation of Lake Superior water levels.



Coordinating Committee (2001) and Mainville and Craymer (2005)

The Earth's crust is still rebounding from loss of the weight of past glaciers. The rate of rebound has been calculated from lake-level gauging stations for less than a century. Lake-level data for thousands of years at each embayment study site provide a much longer record.



Dune development along the Great Lakes shoreline is also related to lake-level history. Studies showing this correlation are critical to land managers seeking to protect and restore dune habitats.